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HABITAT MANAGEMENT SERIES FOR ENDANGERED SPECIES

by Carol Snow, Research Biologist
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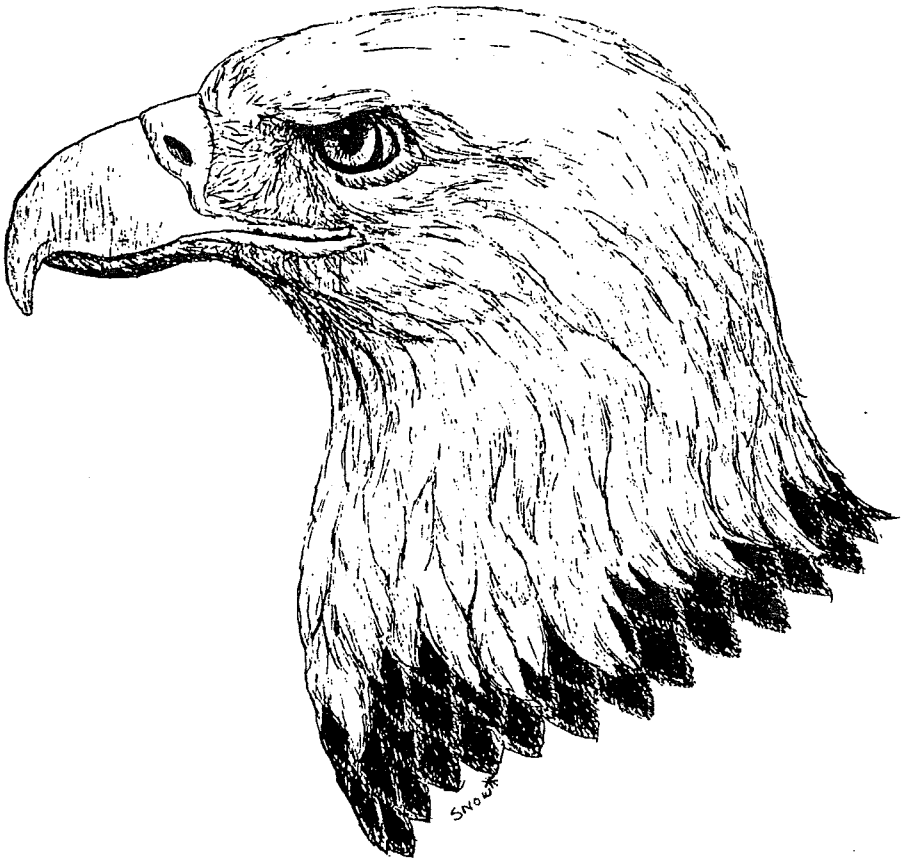
Denver Public Library

Report No. 5

Southern Bald Eagle *Haliaeetus leucocephalus leucocephalus* and Northern Bald Eagle *Haliaeetus leucocephalus alascanus*



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Introduction

The objective of this report is to provide BLM personnel with the latest and most up-to-date information on rare or endangered species occurring on the public domain. This will provide a tool for improved understanding of the interrelationships between the species and its environment and encourage an end product of enlightened land management which will fully consider the species' welfare in all management decisions.

1. Species Description

There are two subspecies of the bald eagle: Haliaeetus leucocephalus leucocephalus, the southern bald eagle, and Haliaeetus leucocephalus alascanus, the northern bald eagle. The only difference in description seems to be that the northern bald eagle is larger and heavier than the southern bald eagle. As with most birds of prey, the female is larger than the male.

Average wing measurements for ten Alaskan male eagles was 24.07 inches. The average wing size of six Alaskan females was 25.54 inches. Average wing size for nine males from Georgia and Florida was 20.83 inches; for five females from these states, the average wing measurements were 22.65 inches (Bent, 1937). Chura and associates (1967) found that the average weight of seven adult male bald eagles at the time of capture in Alaska was 10.7 pounds. An immature female that they captured weighed 12.4 pounds. Alaskan female eagles may weigh over fourteen pounds (Brown et al, 1968; Kalmbach et al, 1964). Robards (1973) has captured an unusual adult that weighed over 16 pounds. Southern bald eagles weigh somewhat less.

When first hatched, a bald eagle is covered with thick, silky down which is longest on the head. The coloration is smoke gray on the back, paler gray on the head and underparts of the body, and nearly white on the throat. When the eaglet is about three weeks old, the light gray or whitish down is replaced by short, wooly, thick down of a dark sooty-gray color. At the age of five to six weeks, blackish feathers begin to appear on the body and the wings. When the eaglet is seven to eight weeks old, it is fairly well feathered and only a small amount of down shows between the feather tracts. The flight feathers are half grown and complete growth within another two weeks (Bent, 1937; Gabrielson et al, 1959).

The coloration of juvenile bald eagles varies. A first year bald eagle is entirely blackish, except for the underwing coverts and the tail feathers, which are mottled with buff or

buff-white and subterminally banded with dark brown. Juveniles after this initial plumage acquire new feathers which have increasing amounts of white, most conspicuously on the underparts, until the brown adult plumage is attained. The head and tail gradually become white and are completely white when the eagle is five to six years old. The beak of juvenile bald eagles is grayish-black, the legs are a pale yellow, the cere is grayish tinged with yellow and the eyes are a dark brown in the first year. The second year, eye color is a light brown. Eye color becomes clear yellow when the eagle is around five years old (Brown et al, 1968; Grossman et al, 1964; Sprunt, 1973). Southern (1964) gives detailed descriptions of the plumages of six age groups of juvenile bald eagles. Both Sprunt (1973) and Robards (1973b) have indicated that they will be publishing data on age groups of juvenile bald eagles.

The adult bald eagle cannot be confused with any other bird of prey. The head and tail are distinctively white. Plumage on the remainder of the eagle's body is brownish black or dark brown. The feet, beak and cere are yellow and the eyes are a lighter yellow. The claws are black. See Figure 1 (Brown et al, 1968; Grossman et al, 1964).

Juvenile bald eagles are often confused with the golden eagle, Aquila chrysaetos (see Figure 2). One major distinction between the two species is that golden eagles have feathered tarsi but bald eagles do not. This is a difficult distinction to make unless a close examination is possible. Secondly, a juvenile golden eagle has a tail with a broad white band at the base. This broad band gradually disappears as the eagle attains adult plumage, but the tail of an adult golden eagle is marked with narrow irregular brown bars at the base and is dark-tipped. The tails of juvenile bald eagles have variably marked gray-mottled or white-mottled feathers which are gradually replaced with white feathers.

Thirdly, the juvenile golden eagle has variably sized but distinct wing patches on the undersurfaces of its primary and secondary feathers and the underwing coverts are dark. The adult golden eagle does not have white wing patches. In the juvenile bald eagle, the white wing patches are lacking and the underwing coverts are mottled with white (see Figure 3).

Both adult and juvenile golden eagles have brown eyes, as does the juvenile bald eagle up to the age of four. Bald eagle eye color is usually yellow by the age of five. Golden eagles have black beaks and yellow ceres. Juvenile bald eagles tend to have brownish beaks and grayish-yellow ceres, although the beaks of first year bald eagles may be grayish black (Sprunt, 1973; Robards, 1973b).

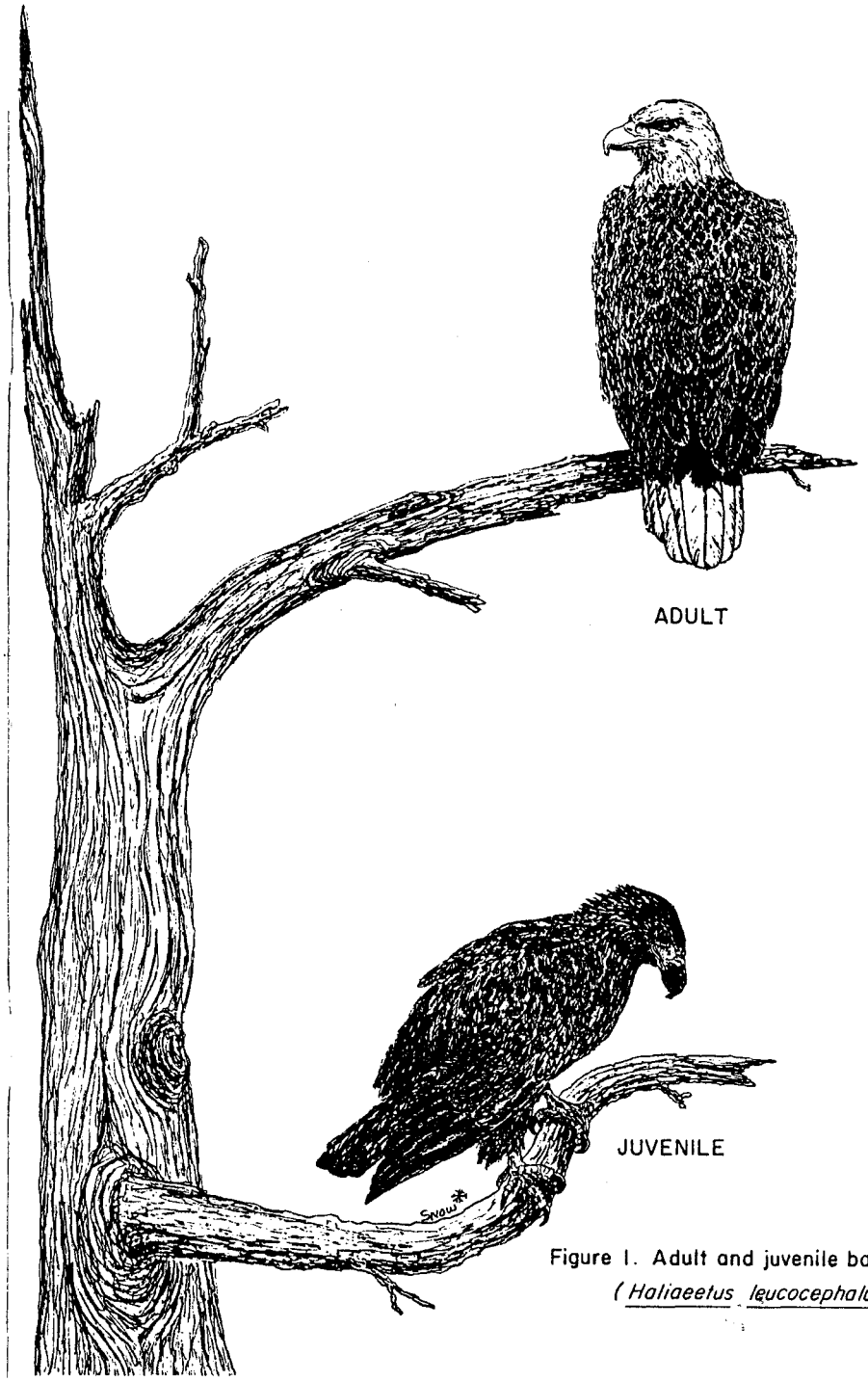
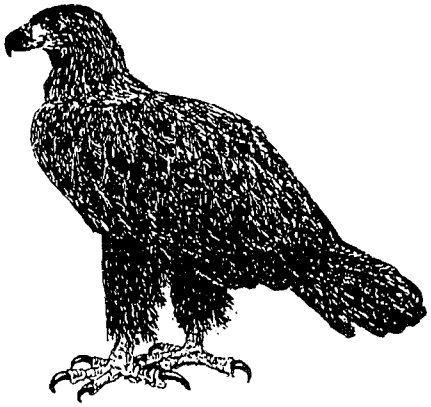


Figure 1. Adult and juvenile bald eagles (*Haliaeetus leucocephalus*)

ADULT GOLDEN EAGLE



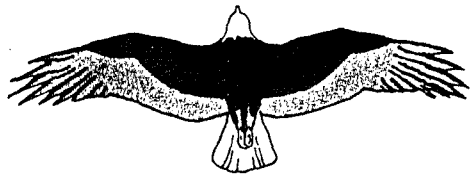
JUVENILE BALD EAGLE

JUVENILE GOLDEN EAGLE

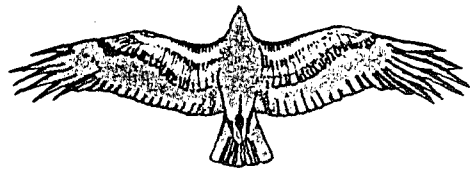
Figure 2. Adult and juvenile golden eagle *(Aquila chrysaetos)* and a juvenile bald eagle *(Haliaeetus leucocephalus)*.

ADULT GOLDEN EAGLE

JUVENILE GOLDEN EAGLE

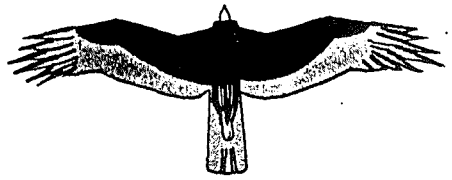


ADULT BALD EAGLE



JUVENILE BALD EAGLE

BLACK VULTURE



TURKEY VULTURE

Figure 3. Flight silhouettes of the golden eagle *(Aquila chrysaetos)*, the bald eagle *(Haliaeetus leucocephalus)*, the black vulture *(Coragyps atratus)*, and the turkey vulture *(Cathartes aura)*.

In flight, juvenile bald eagles may be confused not only with golden eagles, but with vultures if the birds are at a distance. However, flight silhouettes and patterns permit these raptors to be distinguished from each other (see Figure 3) once an observer has had some experience with direct observation of all the birds concerned.

Both the black vulture (Coragyps atratus) and the turkey vulture (Cathartes aura) are found within the bald eagle's range. The black vulture is glossy black and has white wing patches on the undersurfaces of its primaries, but it is much darker in appearance than juvenile bald eagles. Its feet extend beyond its tail in flight. The turkey vulture has two-toned wings; the coverts on the undersurfaces appear very dark, while the undersurfaces of the primaries and secondaries appear much lighter and gray toned. Its tail is long and narrow, and the head appears very small (see Figure 3).

The black vulture's flight pattern consists of soaring with frequent flapping of its wings. The turkey vulture's wings are held in a dihedral and it scarcely flaps its wings at all. The head of the bald eagle projects farther forward than that of the golden eagle. The golden eagle soars more frequently than the bald eagle and its wings are shorter and broader than the bald eagle's wings. The golden eagle's tail is also wider than that of the bald eagle.

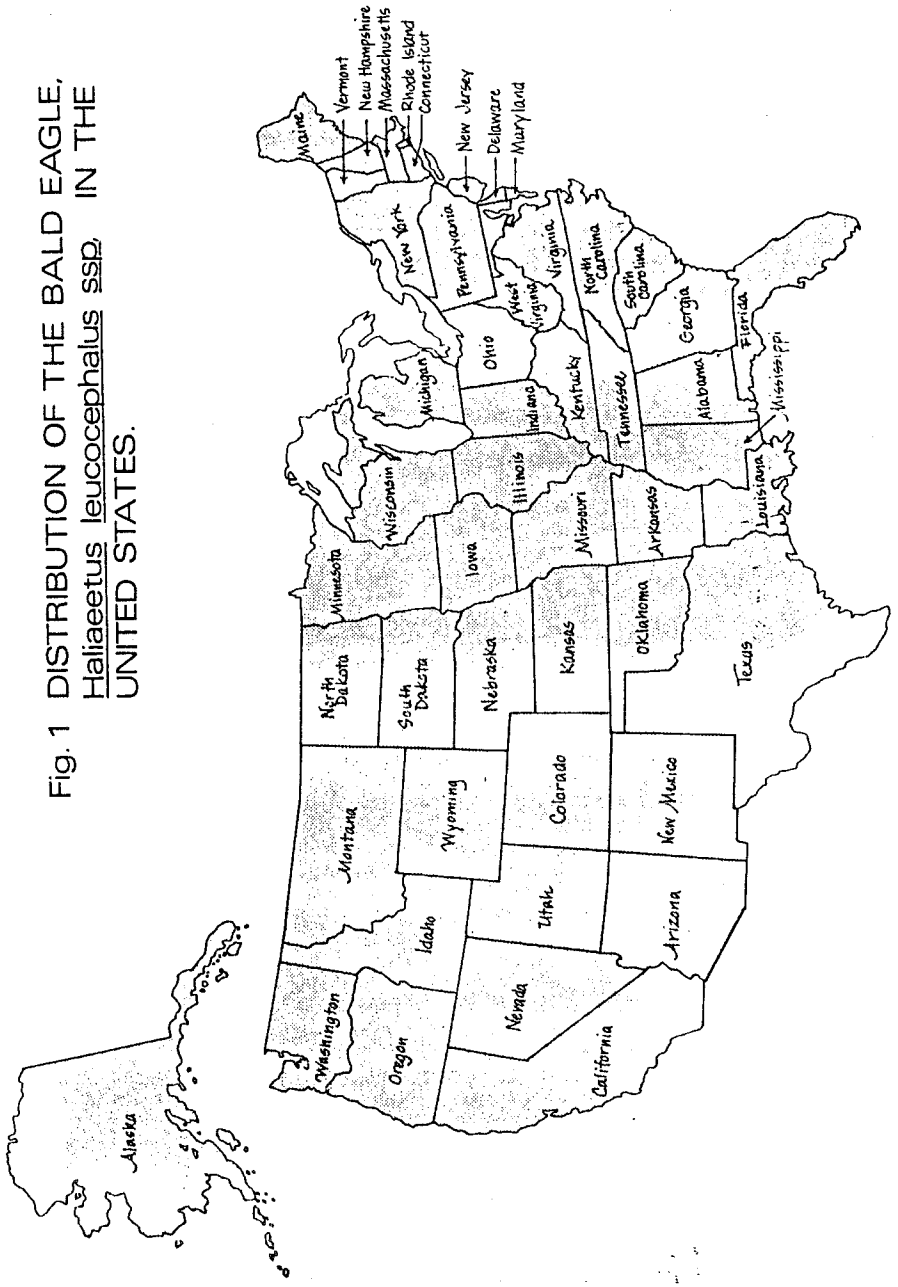
2. Distribution, Present and Former

The bald eagle is a member of the genus Haliaeetus, which contains the so-called fish eagles. It is the only eagle with a distribution restricted to North America (Grossman et al, 1964). Bald eagles are found primarily along the coasts of North America and inland lakes and rivers from the Gulf of Mexico north to the Arctic (see distribution map). They can also be observed along mountain ridges during migration. The former and present distribution are essentially the same, but the numbers of eagles in the continental United States are reduced from former abundance.

The southern bald eagle nests primarily in the estuarine areas of the Atlantic and Gulf coasts from New Jersey to Texas and the lower Mississippi Valley, northern California south to both coasts of Baja California, central Arizona, and New Mexico. Its winter range is essentially the same, but some eagles wander north after the breeding season.

There is some disagreement concerning the distribution of the northern and southern races. In 1937, Bent wrote that he felt that the breeding range of the southern bald eagle should not be considered to extend much farther north than South

Fig. 1 DISTRIBUTION OF THE BALD EAGLE, Haliaeetus leucocephalus ssp. IN THE UNITED STATES.



Carolina, the Gulf states and possibly southern California. He deemed it logical to geographically separate the races at a point midway between the two extremes of size on the basis of data he possessed, this point being somewhat south of North Carolina.

According to the A.O.U. Checklist (1957), the northern bald eagle breeds from Bering Island, the Aleutian Islands, northwest Alaska at the Noatak River, Mackenzie, Manitoba, central Ontario, Labrador, southeast Quebec and the coasts of Newfoundland south to southern Oregon, Idaho, Wyoming, Colorado, South Dakota, Minnesota, Wisconsin, Michigan, Ohio, Pennsylvania, New Jersey and Maryland. The winter range was also given as the breeding range.

The American Ornithologists' Union has indicated that the geographical limits given to indicate the breeding ranges of the northern and southern bald eagles are arbitrary. The two races are separated on the basis of size, and there is a gradual increase from the south to the north. The largest eagles known have come from Bering Island. The eagles in the central section of the United States are intermediate in size.

Gabrielson et al (1959) gave a breeding range of bald eagles in Alaska. They noted that the eagle breeds most abundantly along coasts and islands from Attu through the Aleutians, the Alaska Peninsula and south and east through southeast Alaska. It breeds commonly along the shores of Bristol Bay, around Iliamna and Clark Lakes and less abundantly in suitable locations on the coast of the Bering Sea, north to the Noatak River. It is a summer resident and probably breeds in the interior, especially along the Yukon and Kuskokwim Rivers. It nests in high inaccessible cliffs on Amaknak and Unalaska Islands and on the Aleutian Islands, Kodiak Island, Prince William Sound and the Alexander Archipelago. It has been found in the Copper River Valley, Kenai Peninsula, Tanana, Upper Yukon, McKinley Park, and the lower Yukon and Innoko Rivers.

3. Status and Population Trend

The southern bald eagle is listed as an endangered species by the U. S. Department of the Interior. It has the same status in the IUCN Red Data Book. The northern bald eagle is not considered either rare or endangered.

Although original estimates are not available, the southern bald eagle population apparently has been slowly declining since the advent of the white man on the North American continent. Since World War II there has been a pronounced, accelerated loss of eagles.

Charles L. Broley took up eagle banding in Florida after his retirement as a Canadian banker. In one area in Florida he observed seventy-three breeding pairs in 1946. In 1964, there were 35 breeding pairs in this same region. In the Chesapeake Bay area, the decline was from two hundred pairs in 1936 to seventy pairs in 1966. From 1961 to 1963, about 3700 adult and juvenile bald eagles were counted each year during a nationwide January eagle count sponsored by the National Audubon Society. No observable changes had taken place up to 1966 (Sprunt et al, 1966).

Present population estimates for bald eagles in the continental United States, which would include members of the northern and southern races, is 750 breeding pairs (Knoder, 1972).

From 1917 to 1952, there was a bounty on the northern bald eagle in Alaska. It is estimated that over one hundred thousand eagles were brought in for bounty payment during those years. The original bald eagle population of Alaska is not known, but this state apparently has always been an area of high eagle concentrations. Alaska continues to have the highest bald eagle population in the United States. The most recent estimates place the number of eagles in Alaska between 35,000 and 40,000 (Robards, 1973a). It is difficult to determine if the populations in Alaska are declining. Presently they appear to be stable.

4. Life History

On June 20, 1782, the bald eagle was formally adopted as the emblem of the United States and became the symbolic representation of the American ideal of freedom. The choice of an eagle for the national seal was not unusual, for eagles have been held in high esteem in many cultures throughout the world. The American Indian has continued to believe that the eagle is a "Power" and that eagle feathers give swiftness, strength and endurance (Broley, 1952).

At the time that this eagle was described and named, "bald" meant "white" or "white-faced" and the designation has remained, even though "bald" now popularly means "hairless." The bald eagle has received a wide variety of appellations, ranging from majestic and awesome to cowardly and thieving. Most of these adjectives have been applied through ignorance of the behavior of eagles and the ecological niches that they occupy.

Contrary to popular opinion, eagles do not carry human babies off to their eyries to feed their own young, nor do eagles as a rule attack human beings or carry off full-grown sheep. While the diet of the bald eagle varies according to locality and food availability, fish is the staple food item. Dead and dying fish are eaten as readily as live fish which the eagle catches. In some areas, eighty to ninety percent of the diet is fish.

In the continental United States and Canada, fish species observed to be eaten by bald eagles include bowfin (Amia calva), brown bullhead (Ictalurus nebulosus), white sucker (Catostomus commersoni), chain pickerel (Exox niger), cisco (Coregonus), perch (Percidae), alewife (Aloga pseudoharengus), striped bass (Morone saxatilis), lingcod (Ophiodon elongatus), sculpins (Cottus sp.), arrowtooth flounder (Atheresthes stomias), red Irish lord (Hemilepidotus hemilepidotus), herring (Clupeidae), carp (Cyprinus carpio), channel catfish (Ictalurus sp.), gizzard shad (Dorosoma cepedianum), American eel (Anguilla rostrata), and oyster toadfish (Opsanus tau).

Herring (Clupeidae) is apparently a preferred food along the coast of Alaska. The bald eagle is an opportunist and readily consumes carrion, including the remains of poultry, livestock, whales, otters, seals, fish, deer and rough fish discarded by commercial fishermen (Kalmbach et al, 1964; Broley, 1958; Herrick, 1933; Brown et al, 1968; Bent, 1937; Southern, 1963; Wright, 1953; Munro, 1938; Hancock, 1964; Retfalvi, 1970; Kenyon, 1971; Barnes, 1951; Chrest, 1964; Murie, 1940; USDA et al, 1972; Hensel et al, 1964; Robards, 1973b).

In Alaska, bald eagles eat waterfowl, spawned-out salmon (Salmonidae), smelt (Osmeridae), dolly varden (Salvelinus malma), Arctic char (Salvelinus alpinus), longnose lancetfish (Alepisaurus ferox), walleye pollack (Theragra chalcogramma), Pacific cod (Gadus macrocephalus), greenling (Hexagrammos sp.), Atka mackerel (Pleurogrammus monopterygius), shearwaters (Puffinus sp.), fulmars (Fulmaris glacialis), cormorants (Phalacrocorax sp.), gulls (Larus sp.), murres (Uria sp.), tufted puffin (Lunda cirrhata), paroquet auklet (Cyclorrhynchus psittacula), ancient murrelet (Synthliboramphus antiquum), old-squaw (Clangula hyemalis), common eider (Somateria mollissima), crested auklet (Aethia cristatella), other sea birds and squids, crabs, snails, clams and sea urchins.

Where available, fish are the preferred food. Wright (1953) conducted food preference tests from June through September. At least one species of fish, one mammal and one bird were offered at each test. Black ducks (Anas rubripes) and snowshoe hares (Lepus americanus) were offered in combination

with fish of one or more species. The eagles always took the fish, indicating that at least during this time of year, fish were preferred. Brown bullheads (Ictalurus nebulosus) were the preferred species even when offered with other species of fish.

The adaptability of the bald eagle's food habits can be demonstrated by a survey of food habit studies conducted in different areas of the United States and Canada.

Retfalvi (1970) discovered that feral domestic rabbit carrion was the most common food item of bald eagles nesting on San Juan Island, Washington. Adult and juvenile eagles were often observed perching on fence posts in the middle of fields with an abundance of rabbits. The rabbits continued to feed even with eagles perched only a few yards away from them, but headed for cover when the eagles flew.

No kills of rabbits by the eagles were ever observed. The mortality of rabbits from collisions with automobiles and from heavy hunting pressure was an estimated 450 rabbits killed per day during the summer on San Juan Island. Mowing machines also took a high toll of rabbits, so that there was a great abundance of carrion.

Fish constituted the second most frequent item fed to the young eagles, and a preference for fish was again exhibited, because the eaglets would not eat rabbit carrion when fish was brought to the nest.

Dead sheep constituted the most prominent item in the diet of bald eagles wintering in the Southern Gulf Islands, British Columbia (Hancock, 1964). All of the larger concentrations of eagles observed were associated with sheep carcasses. For six years, Hancock and a local sheep rancher spent hundreds of hours observing eagles from blinds and not once did they observe an attack on a young lamb or on a ewe giving birth. They did frequently observe eagles eating afterbirths.

In 1960, a concentration of wintering bald eagles was observed in Utah, in the Oquirrh and East Tintic Mountains. Studies of these birds by Edwards (1969) indicated that the black-tailed jackrabbit (Lepus californicus) was the major food item. Swisher (1964) observed that ducks were the principal food of bald eagles wintering near the Bear River Migratory Bird Refuge, Box Elder County, Utah. The roost for these birds was fifteen miles from Bear River, indicating that these eagles were travelling some distance to get to their hunting grounds.

Southern (1963) watched bald eagles use four basic methods to capture live fish in the winter.

(1) The eagle swooped from a perch and struck at a fish with its talons. With this technique, the eagles were successful twenty-five percent of the time. If the eagle caught a fish, it flew to a nearby tree or onto the ice and ate it. Other adults and juveniles might try to steal the fish. Juveniles seemed more eager to take fish from adults than to catch their own.

(2) The eagle flew back and forth or circled open water, then swooped down and struck with its talons. Eagles using this method were successful approximately twenty-five percent of the time.

(3) The eagle stood on the edge of the ice and reached into the water with its talons or beak. Very few eagles used this technique.

(4) The eagle waded in shallow water and caught fish with its beak. This was the most successful method. Adults and some juveniles waded up to their bellies and usually submerged their heads when capturing fish.

Retfalvi (1965) observed similar methods being used by the eagles on San Juan Island. The most often practiced fishing method consisted of a steep dive from a tree perch by the shore, usually with a break in speed as it neared the surface of the water. He also saw eagles flying low over the water and snatching a fish without any break in the flight. Retfalvi observed eagles make a powerful downward thrust of the wings and a sudden turn in the manner of a twisted somersault, then dive headlong toward the water with their wings held close to the body. These dives usually terminated with a wetting of the legs and a return to their former height with quick wingbeats.

Munro (1938) observed bald eagles hunting ducks. Basically, when the eagle had flown over a flock of ducks, the ducks would dive. The eagle would follow the underwater movements of a duck and each time it emerged, the eagle would swoop down to the water and the duck would dive again. This would be repeated until the duck was exhausted and the eagle would pick it up. Munro observed that some ducks taken in this manner were incapable of flight because of gunshot wounds or other injuries. He also observed bald eagles harassing coots, which would move together in a close flock.

After diving, the eagle would ascend, dive again, and repeat the process until stragglers appeared and then would pursue the coots which had separated from the main flock. Paired eagles have been observed to work in unison, taking turns in the pursuit of the flock (Robards, 1973b).

Edwards (1969) had extensive opportunities to observe eagles hunting, noting that bald eagles exhibited a tendency to hunt more often in small groups and cooperate in the flushing and killing of prey, whereas adult golden eagles usually hunted alone or in pairs.

The basic hunting technique consisted of short coursing flights back and forth over vegetation concealing prey. There was much intermittent perching and since several birds were present at any one time, some would be sitting and some would be flying. Perching was as much a flushing technique as low flight because rabbits would bolt from cover as often because of an eagle landing near it as from an eagle flying low overhead.

Bald eagles were observed to land and walk along the ground through low brush in what apparently were specific attempts to flush prey, because flying eagles subsequently made kills. Almost all hunting was conducted while the eagles flew one to three meters above the ground. From observation it appeared that about one half of the rabbits flushed were killed within thirty meters of attempted escape if two or more eagles were hunting together.

More time was actually spent perching than actively flying when the eagles were hunting. A number of objects were used as perches, including sagebrush, soil hummocks and level ground. When a kill was made, the eagle preferred to take the major portion of its prey to posts, limbs or rock outcrops for consumption. It might then sit there for several hours before flying back to the primary roost area.

More than one bird usually fed on any rabbit killed, and the flesh and many bones were completely consumed. Remains usually consisted of the vertebral column, hind leg bones and widely scattered fur. Bald and golden eagles sometimes shared a carcass equally, and ravens (Corvus corax) were often allowed at a carcass at the same time (Edwards, 1969).

The weight-lifting capacity of eagles is greatly overestimated by people unfamiliar with the principles of aerodynamics or the size of the eagles themselves. There are innumerable accounts in the newspapers of eagles carrying off babies,

sheep, deer, goats and attacking human beings. These eagles reportedly have been as heavy as fifty pounds and have had wingspreads from three to fifteen feet (Walker et al, 1940).

Most people unfamiliar with eagles are astonished when they learn that an eagle may weigh eight to fourteen pounds on the average and that maximum wing span is eight feet. But the bulk of an eagle is its feathers, and its bones are hollow and therefore much lighter than mammalian bones. Even military aircraft are incapable of lifting more than their own weight, so it is difficult to understand how people could think that an eagle could carry off another organism that was larger than itself.

Walker et al (1940) conducted tests on the lifting capacity of a golden eagle. Since golden and bald eagles are similar in size and weight, they felt that both should have similar weight-lifting capacities. They launched their eagle from a fifteen-foot-high platform when a wind of ten mph was blowing. They put the eagle through six flights with a twenty-minute rest between each flight.

When the eagle was carrying two one-pound weights attached to its legs, it flew one hundred and sixty-two yards easily. When the weights totalled four pounds, it flew 64 and 58 yards, but the flight was strained. Carrying eight pounds, it flapped its wings wildly and managed to fly only ten and fourteen yards. Twenty minutes after this final test, the eagle was flown unweighted and soared 460 and 620 yards before it was called down to the glove.

The vocalizations of the bald eagle tend to be described in rather derogatory terms. Bent (1937) described the bald eagle's voice as ridiculously weak and insignificant and more of a squeal than a scream. Brown et al (1968) described the voice as an unimpressive squeaky cackling. Edwards (1969) described vocalizations that sounded like glass breaking. The voice of the female is harsher than that of the male.

Retfalvi (1965) has described the vocalizations of bald eagles in some detail. He noted that there are three basic sounds which the eagles make in different patterns, depending upon the situation: (a) hoarse sounds given in quick succession from the throat, sounding like kah-kah-kah; (b) a chuckling sound, similar to horse neighing, sounding like ye-ha-ha ye-ha-ha ha-ha-ha; (c) a gull-like yaap-yaap-yaap, which is given mainly by the eaglets and the female.

The intensity and frequency of the calls varied with the situation and with the time of day. A "threat" call was often uttered when human beings, adult or juvenile bald eagles approached the nest. This call consisted of a repeated harsh kah-kah-kah followed by the chuckling sound. A "mild threat" call was given when redtailed hawks (Buteo jamaicensis) and turkey vultures (Cathartes aura) approached. This was a sharp chuckling sound without the final ha-ha-ha.

The "annoyance" call was made more often by the female when she was guarding the nest alone. Seabirds, crows and airplanes would stimulate the call, which was the chuckling sound with the final ha-ha-ha uttered slowly, and often combined with the gull-like call. A "greeting" was generally expressed when a mate returned to the nest. This was a highly pitched chuckling sound given in a laughing manner and was often heard during courtship. Both birds would make the call. When vocalizing, the bird would draw its head backward until it almost touched its back. The "hunger" call was most often heard from the eaglets, especially during the last two weeks before the family unit dissolved. This was the gull-like call.

Eagles are primarily resident in their range, particularly in the more southern latitudes. The southern bald eagle is considered resident in Florida, although there is some northward movement during the summer when eagles have completed the breeding cycle. Bald eagles will winter as far north as open water and an adequate food supply is available (Bent, 1937; Brown et al, 1968).

It is primarily the eagles from the northern states and Canada that move southward. They tend to gather along rivers, lakes, national wildlife refuges and other places where food is available. The lakes and dams constructed on the Mississippi and the Missouri Rivers have changed the distribution of wintering bald eagles considerably. These areas provide open water for feeding and abundant fish in the tailraces. National and state refuges harboring waterfowl concentrations also attract eagles, particularly during the weeks following hunting season when many crippled ducks and geese are available. Large impoundments in other parts of the United States also provide wintering territory.

Immature birds tend to move south earlier and travel farther south than the adults. They also move north later in the spring than do adults (Sprunt et al, 1966). Returns from eagles banded in Saskatchewan have indicated that some Canadian birds may fly as far south as Texas and Arizona (Gerrard, 1973).

Winter counts of bald eagles were conducted by the National Audubon Society in January of each year because bald eagle movements were at a minimum. Four areas of eagle concentration were noted in the continental United States. The Middle West contained the largest number of wintering eagles. The Mississippi Valley from Minnesota south to the southern tip of Missouri and northwestern Tennessee and including parts of the Wisconsin and Illinois Rivers was a prime area of concentration. More than one third of the entire continental United States population of bald eagles wintered in the Mississippi Valley.

The second most important area for wintering eagles was the Northwest: Washington, Oregon, Idaho and Montana. They were found on the coast and along the major river systems. The Snake River in Idaho was most frequented. This area was utilized by approximately twenty percent of the bald eagles. Pend Orielle Lake in northern Idaho has a concentration of approximately 150 bald eagles during November and December. During this time the eagles feed on kokanee (Oncorhynchus nerka) that die after spawning (Cuplin, 1973).

During January the bald eagles in Florida are breeding and therefore cannot be considered as part of the wintering population. They were included in the overall population figures for the January counts because Florida has one of the highest remaining eagle populations in the continental United States. The resident eagles in Florida comprise around fifteen percent of these total winter counts.

The Middle Atlantic states, particularly the Chesapeake Bay region, comprised the remaining area of wintering bald eagle concentrations. Around five percent of the total continental eagle population wintered here. The remaining bald eagles were scattered throughout the rest of the United States. Colorado, Maine, Wyoming, Utah, California, Texas and South Carolina had some of the higher concentrations (Sprunt et al, 1961, 1962).

In 1964, Swisher reported the discovery of a winter roosting area of bald eagles in northern Utah. The location was the west fork of the basin of Willard Canyon, which is 15.5 nautical miles from Bear River in Box Elder County, Utah.

1960 was the first year that wintering bald eagles were observed in three large valleys in parts of Utah, Tooele and Juab Counties. Four roosts were found. Two of the roosts were located in canyons of the north-south oriented Oquirrh and East Tintic Mountains. The other two roosts were discovered in the broad, nearly treeless valleys. The

two canyon roosts received the greatest use, particularly the one in the Tintic Mountains. Such concentrations are uncommon because the valleys are arid and not associated with water (Edwards, 1969). See Section 6.

The first eagles to arrive were adult birds. Immature eagles followed within a few days. The first eagles began arriving in November. The adults departed abruptly in April, while the immatures remained a little longer. The total population for the whole area remained relatively constant at mid-winter, but the numbers at any one roost showed a fluctuation, changing with the weather, variation in prey populations and human interference.

A small number of immature golden eagles were observed to roost with the adult and juvenile bald eagles. There was a high degree of interspecies tolerance. Agonistic behavior between bald and golden eagles was limited to supplantations at roosts or perches. Juvenile golden eagles were more aggressive. At times they deliberately dislodged several bald eagles from their perches, but the golden eagles did not perch. They would continue harassing the bald eagles which had been perched in a particular tree until the tree was nearly vacant. The amicability between the species extended to golden and bald eagles sitting side by side on the same limb.

In Alaska, the Chilkat Valley near Haines, north of Juneau, is an area of high concentrations for wintering bald eagles. As many as 3000 to 3500 eagles may be observed here from October to January, attracted by spawned-out salmon. This is possibly the highest wintering concentration of bald eagles in existence. In the spring, large numbers of eagles can be seen feeding on spawned-out smelt in the Stikine River near Wrangell, the rivers of Berners Bay near Juneau and along the rivers entering Prince William Sound and Cook Inlet near Anchorage (USDA et al, 1972; Robards, 1973b).

There seemed to be very little hostility towards other species of birds. Bald eagles not infrequently shared their kills with ravens in Utah. Although in New Brunswick waterfowl exhibited caution around bald eagles in the winter, it was not unusual for females and their broods to swim right beneath perched eagles. For the most part, eagles will ignore harassment from alarmed songbirds or crows. They may move to other perches if the harassment doesn't decrease after a time.

The only instances of aggression that Edwards (1969) noted was when bald eagles would dive at great horned owls (Bubo virginianus) caught in traps. Even though they dove at the owls, they did not actually touch them. This behavior was not observed when smaller owls were caught in the traps.

The osprey (Pandion haliaetus) lives on a diet of fish, and is also known as the fish hawk. The bald eagle sometimes will force an osprey to drop a fish which it has caught and then pick up the fish. This practice has not been studied extensively, but during the past ten years, observers in the Chippewa National Forest have not seen an eagle take a fish from an osprey (Rossman et al, 1971; Bent, 1937).

Ospreys generally offer little or no resistance to adult bald eagles and will even leave their nests when an adult eagle approaches. However, juvenile bald eagles are attacked if they approach an osprey nest. The osprey attack frequently results in the eagle changing its flight direction (Retfalvi, 1965).

The interrelationships of non-breeding bald eagles is one of indifference and mutual tolerance. A number of them may gather at certain locations because of a common interest in certain food items, such as a large carcass. Juvenile bald eagles have not been observed to exhibit antagonistic behavior towards their own species.

Red-tailed hawks (Buteo jamaicensis) are more aggressive toward bald eagles than ospreys are. Juvenile bald eagles seem to react more readily to harassment than adults do. In situations where an adult eagle will merely continue its flight uninterrupted, juveniles will exhibit a defensive reaction. This defense consists of the eagle flipping on its back around the anterio-posterior axis and meeting the attacker with its talons, then quickly flipping over and continuing its flight. It will do this until the attacks are stopped (Retfalvi, 1965).

Fifty years is not an unusual life span for an eagle in captivity. Like other long-lived species, it takes several years to achieve sexual maturity and productivity is low. Excessive mortality in such a species has more serious consequences than mortality in a species with high fecundity.

Several investigators have conducted studies on bald eagle mortality. Coon et al (1970) examined 76 bald eagle carcasses. Fifty-five of these birds had died of injuries. Of these 55 eagles, 45 had been shot, seven died from impact injuries, two died in traps and one was electrocuted. Sixty-two percent of the 76 birds had been shot.

Sprunt (1972) reported that of 163 bald eagles where the cause of death was known, 91 (55%) had been shot. Many of these birds were in subadult plumage. Misidentification as a golden eagle may be part of the reason why more juveniles are shot than adults. Behavioral differences may also be involved. Juvenile bald eagles tend to stay perched much longer than adults when a human being approaches and are thus easier targets for people with firearms. Although both the bald eagle and the golden eagle are fully protected by federal law, shooting is still the greatest direct mortality factor.

Electrocution is another cause of mortality. This is primarily a problem with older transmission lines. Since power poles often provide the only available perches in treeless country, they are frequently used by birds of prey. The way an eagle lands and takes off influences whether or not it will be electrocuted. Electrocution is a minor factor compared to shooting, but losses in some areas may be considerable. Insufficient data is available to determine the impact of electrocution on bald eagle populations (Sprunt, 1973).

Another threat comes from the use of poisons for predator and rodent control. Although minimal dosages only are supposed to be used in poison baits, sometimes the dosages exceed minimal levels and a poison such as 1080, which is specifically designed to kill canines, may still kill eagles. Thallium sulfate is definitely dangerous to eagles. At least eleven bald eagles were poisoned by thallium sulfate in Wyoming (Sprunt, 1972).

Mulhern et al (1970) analyzed 69 bald eagles for organochlorine residues. Six of the 69 eagles had levels of dieldrin sufficient to be lethal. Two more eagles had levels high enough to be contributing factors to their deaths. One died from DDT poisoning. Illegal shooting was the most frequent single cause of mortality among eagles examined in this study. Twenty-eight (40%) of the specimens examined died from shooting.

Two bald eagles found in Minnesota in 1969 were victims of mercury poisoning. It is suspected that the birds accumulated the mercury by eating fish from mercury-polluted waters. This may be an additional mortality factor for the seriously declining populations (Anon., 1970).

5. Reproduction

The breeding season of bald eagles varies with latitude. Territorial defense is generally considered a part of breeding behavior. In Alaska, the northern bald eagles generally defend their territories from early April to September (Chrest, 1964; Robards et al, 1966; USDA et al, 1972). Retfalvi (1965) observed that the breeding season for northern bald eagles on San Juan Island, Washington, began in mid-February. Murphy (1965) observed the beginning of nesting activities in mid-April in Yellowstone National Park. Herrick (1932) observed bald eagles rebuilding nests in February in Ohio. The southern bald eagle in Florida may breed at any time from November through June (Bent, 1937).

Bent (1937) reported on sixty-two records of known dates when eggs were laid by bald eagles in Alaska and Arctic America. The time span encompassed March 24 to June 24. For thirty-one of these sixty-two records, the eggs were laid from May 7 to May 14. Bent had forty records for bald eagles from Oregon to Mexico which encompassed a period of February 18 to April 1. For twenty of these, the time span was March 2 to March 11.

There is little descriptive material on bald eagle courtship. Retfalvi (1965) mentions the "cartwheel display" as the most spectacular courtship maneuver. The eagles swoop alternately at each other, avoiding contact by side slips and mounting fast in the air. One bird turns on its back and grasps the extended talons of the oncoming bird. The pair falls toward the earth in a spinning cartwheel fashion, releasing their hold a few yards above the surface of the water or ground.

Territorial defense may be exhibited two to three months before the eggs are laid. Rehabilitation of established nests occurs every year. New sticks will be added or old ones rearranged. Materials used depend upon the locality of the nest. The female does most of the nest building, but both birds bring in nesting material. Most eagles show great tenacity to their nesting sites and tend to occupy the same territories. It is believed that a pair remains mated for as long as both are alive (Herrick, 1924c; Retfalvi, 1965; Robards et al, 1966; Brown et al, 1968; Bent, 1937).

A nest that is constructed for the first time consists of a great mass of sticks. Most of these will be picked up from the ground and carried to the nest site in the eagle's talons. Each stick is laid with the aid of the beak. As the number of sticks increases, coarser materials are interlaid on the

periphery. The center and miscellaneous spaces are filled with finer materials such as dried grasses and herbs. Sometimes branches will be snapped off dead trees while the eagle is in flight. Greens of one sort or another are often brought to the nest after initial construction is completed (Herrick, 1924a). Mathisen has observed that in the Chippewa National Forest, a sprig of white pine is present in nearly all eagle nests. Regardless of the species of the nest tree, white pine only was used, even though red pine is three times more abundant than white pine. The reasons for the use of the white pine, which is placed randomly in the nest, is unknown (Mathisen, 1970; Wechsler, 1971).

Some pairs of eagles do not breed every year. They may repair their nest and remain in that vicinity through the season but never lay any eggs. If the first set of eggs is taken early enough, the female may lay a second set after an interval of four weeks or more (Bent, 1937).

The usual clutch size is two eggs about the size of domestic goose eggs, although occasionally three eggs may be laid. The incubation period is approximately 35 days. Both parents incubate the eggs and care for the young when they hatch. Incubation begins when the first egg is laid so that there is a size difference between hatchlings (Bent, 1937; Brown et al, 1968; Herrick, 1932; Retfalvi, 1965; Dixon, 1909; Chrest, 1964).

Although bald eagles tend to ignore other species of birds, this behavior is altered when incubation begins and when the eaglets are very small. During this time avian intruders in the eagle's territory, such as crows and other raptors, are not tolerated (Herrick, 1932). Most nesting eagles are non-aggressive towards human intruders. They may fly above the nest and scream for a short time, but generally leave the vicinity when human beings come near their nest. Murphy (1962) noted an exception to this general pattern of behavior. While attempting to photograph a nest in Yellowstone National Park, a photographer was struck by one of the adults. The lacerations were superficial and the eagle did not strike the man very hard. This particular pair of eagles was more agitated and remained closer to the nest when intrusion occurred than any other pair of eagles under Murphy's surveillance.

During the first three to four weeks of the young eagle's life, one or both parents will be at the nest constantly. The guarding parent will often be on a nest-perch or on a part of the nest tree above the nest. The parents go to the nest to

deliver prey, feed and brood the young. Both the male and the female feed the young birds, although the female broods them more frequently. Night brooding may last until the young are a month old (Herrick, 1933).

Retfalvi (1965) observed that the female was at the nest three times as much as the male. He also observed that most of the feeding of the young was done by the female, although the male and the female brought food equally. When the young were small, feeding took place as soon as prey was brought to the nest. When they were older, feeding might not occur until several hours after prey had been procured.

The eaglets are unable to feed themselves until they are around seven weeks old. The feeding method consists of the female tearing off strips of food with her beak and holding these strips to the beaks of the eaglets. If two young hatch, the larger will usually get food first, and if food is in short supply it will receive the larger share if not all of it. Usually, while the larger eaglet is swallowing a piece of food, the smaller will have a chance to receive food from the female (Herrick, 1933; Retfalvi, 1965). Retfalvi (1965) calculated that the average food consumption of newly hatched eaglets was three fourths of an ounce a day. Ten to twelve weeks later, when the eaglets were ready to leave the nest, food consumption averaged three and three fourths pounds per day.

Eaglets use their wings extensively from the time they hatch, but for the first four weeks the wings are used as a support when crawling. Wing-flapping begins to develop after the age of one month and becomes more frequent as the eaglets mature. About the time that eaglets begin to exercise their wings, they also spend a lot of time preening the growing feathers. During the last week in the nest, activities center on feeding, reactions to each other and to the parents, play and flying exercises.

Wing-flapping becomes more and more frequent as the time nears for leaving the nest. When exercising, the eaglets usually hold onto a branch embedded in the nest and with strong wingbeats perform the motions of flying. After some coordination is acquired, they do not hold onto the branch but flap in place. As control over their wings increases they start taking short excursions to perches around and above the nest. When they first leave the nest, they frequently return to it at night when the parents might bring in fresh prey.

During the last several weeks that the eaglets are in the nest, the parents spend no more than fifty percent of their time around their young, and the eaglets themselves do not seem to be very interested in the adults (Herrick, 1924b, 1924c, 1933; Retfalvi, 1965).

Kussman et al (1972) observed the "fledging flight" for several juveniles. In all cases this first flight from the nest was undirected and uncoordinated, usually a long glide to the ground. Most juveniles ended up on or near the ground during the first few days after fledging. Retfalvi (1965) also observed that the first few landings of newly fledged eagles were awkward and uncoordinated. During this time the young eagles are vulnerable to attacks by other raptors and possibly mammalian predators.

Several observers have noted that fratricide among nestlings is not uncommon (Dixon, 1909; Brown et al, 1968; Bent, 1937). They report that frequently only one nestling fledges. However, the frequency of fratricide and its influence on productivity is not clearly understood. Productivity data from Alaska is at variance with the assumption that usually only one eaglet fledges, since as many as 35% of the successful pairs in some Alaskan populations produce two young annually. In the Great Lakes region only 3% of the nests produce two young (Sprunt et al, 1973).

The average number of young produced during a study by Chrest (1964) in the Karluk Lake drainage, Kodiak Island, Alaska, was 1.8 young per successful nest. However, when unsuccessful nesting attempts are taken into consideration, the average is one young per nest. The number of young per nest attempt in the Great Lakes area is only .14 eaglets (Sprunt et al, 1973).

6. Habitat Requirements

A great portion of an adult bald eagle's life centers around the nesting territory. Selection of nesting sites varies tremendously even within the same state and depends on the species of trees growing in a particular area. When nesting season is finished and migration occurs, habitat requirements are somewhat altered. One of the major differences is that migratory eagles do not defend a territory.

Herrick (1924) found that sycamore (Plantanus sp.) and shellbark hickory (Carya laciniosa), usually dead or dying, were the favorite nesting trees of bald eagles along Lake Erie. Mathisen (1968b) and Juenemann et al (1972) observed that

red pine (Pinus resinosa) and white pine (Pinus monticola) are the usual nest trees in the Chippewa National Forest, Minnesota. The pines selected are the large ones which were left as seed trees because of the 1902 Morris Act, which stipulated that five percent of the total number of red and white pines with a diameter-breast-height greater than ten inches be left as seed trees. Many of the trees protected by this act have become eagle nest trees and are aged between 116-184 years. Over one half of the nest sites surveyed occur less than one half mile from water.

Murphy (1965) found eagle nests in living Engelmann spruce (Picea engelmanni), lodgepole pine (Pinus contorta latifolia), whitebark pine (Pinus albicaulis), and Douglas fir (Pseudotsuga menziesii) in Yellowstone National Park. The tree selected was characteristically the largest or the stoutest in the immediate surroundings. All nests were located between ten to fifteen feet below the tree top.

Retfalvi (1965) found that all bald eagle nests on San Juan Island were in Douglas fir, usually the tallest tree of the surrounding forest stand. The mean height of nine trees with bald eagle nests was 102.7 feet. Many nests were built in dead or dying trees.

Several studies have been conducted on the nesting ecology of bald eagles in Alaska. Eagles nest primarily in Sitka spruce (Picea sitchensis) and cottonwoods (Populus sp.), depending on what is available (USDA et al, 1972).

Poulin (1968) and Corr (1969) observed that Sitka spruce is the most frequently used species of tree in the Tongass National Forest within a sixty-mile radius of Petersburg, Alaska. They also found eagle nests in western hemlock (Tsuga heterophylla) and yellow cedar (Chamaecyparis nootkatensis). Robards et al (1966) found that ninety percent of nests located on Admiralty Island were located in Sitka spruce. The remainder were located in hemlocks.

Robards et al (1966) also observed eagle nests in the Chilkat Valley. Most of them were located in large cottonwood trees growing along river channels. Troyer et al (1965), Hensel et al (1964) and Chrest (1964) discovered that the major tree species utilized for nesting by bald eagles in the Karluk Lake drainage on Kodiak Island was live cottonwood. Other areas used were rocky cliffs or the bases of alder trees (Alnus sp.) protruding from rock cliffs along the seashore. These nests were usually found on prominent points, pinnacles and islets from 40 to 200 feet above sea level.

Hensel et al (1964) found that the average height of cottonwoods used for nest trees was 76 feet. Chrest (1964) found that the average height for cottonwoods used as nest trees in his study was 74 feet. Hensel et al (1964) also found that the range in height from the ground to the nests was 42 to 65 feet. Tree height above the nests averaged 23 feet. The mean diameter of the nesting cottonwoods was 24 inches. Chrest (1964) found the same average dbh. The nests themselves were 40 to 62 feet above the ground.

Corr (1969) and Poulin (1968) obtained some figures for Sitka spruce trees. Poulin found that the average height of nest trees was 118 feet. The average height of the nests in the trees was 96 feet. Corr found an average height for Sitka spruce of 125.2 feet. Western hemlocks averaged 110.4 feet.

Corr (1969) defined five categories of nest forms:

1. nest located in the upper whorl of branches which formed a bowl after the tree top was damaged;

2. nest located in the crotch of a U-shaped branch;

3. nest located in the upper whorl of branches with the dead top above the nest;

4. nest located in a normal tree hidden by foliage;

5. nest located in a dead tree, bare of foliage.

Fifty-seven percent of the nests Corr observed were in normal trees and hidden by foliage. The remaining nests were rather evenly distributed among the other types. Most nests were probably found in normal trees because more trees of this type were available.

There are many factors involved in nest site selection, but certain elements seem to be consistent. A clear flight path to a close point on a beach or a river is one of those elements. The largest tree in a stand is chosen, even if the eagles are nesting in stunted timber. An open view of the surrounding area is another common characteristic. Proximity to a body of water, usually a lake, river or large stream appears to be another requisite since the major food item of eagles is fish. Most nest trees are within one half mile of water and many are considerably closer. Freedom from human disturbance or intervention is one of the most variable factors involved (Robards et al, 1966; Retfalvi, 1965; Corr, 1969; Hensel et al, 1964; Murphy, 1965).

In areas where ospreys are also nesting, there may be some difficulties with nest identification. Mathisen has observed five basic differences between the nests of bald eagles and ospreys in the Chippewa National Forest. These factors include nest tree species, condition of the tree, timber type, location of the nest in the tree and the size and shape of the nest.

Bald eagles nest primarily in red and white pines. Most osprey nests are in spruce (Picea sp.) or tamarack (Larix laricina). Eagles usually nest near large water areas, but ospreys frequently nest near small potholes or beaver ponds. The eagles almost always nest in live trees, although sometimes the tops of these trees may be dead. The majority of osprey nests are in dead trees.

Eagle nests are usually located below the crown at a main branch and usually receive some cover from the part of the tree above the nest. Osprey nests are often located at the very top of the tree. Eagle nests also tend to be larger than osprey nests, flat topped, and somewhat cone shaped. Osprey nests are basically more rounded in appearance (Mathisen, 1968b; Wechsler, 1971).

Juenemann et al (1972) have been conducting studies on the influence of human activities on nesting. Human actions occurring within one mile of nests were evaluated. Factors were rated arbitrarily one to four for severity and one to four if occurring up to one fourth, one half, three fourths or one mile from the nest. As an example, if a disturbance was rated three in intensity and occurred one half mile from the nest (a rating of 3), the disturbance effect was nine.

The disturbance indices they studied ranged from eighteen to one hundred eighty-two. They observed that there was an indirect relationship between apparent nesting activity and degree of disturbance; an indirect relationship between realized production and degree of disturbance, and a better ratio of activity and productivity with lesser disturbance.

Power and telephone lines, remote buildings, trails and abandoned logging roads, winter roads, existing rice paddies and developed plantations appeared to be the least disturbing to eagles and were placed in category one. Category two included a railroad which ran within one mile of six nests and had a traffic rate of one train per day. Inactive or seldom used roads were also included here.

Category three consisted of active roads (surfaced and non-surfaced) as well as logging conducted in the area between November and March when the birds were not present. A railroad with a traffic rate of four trains per day was included. Category four included the most disturbing factors: medium to heavy recreational use, e.g., seasonal activity around resorts and campsites; active construction of rice paddies, tree plantations and the blasting of potholes. Timber industry activities, especially plantation preparation occurring between March and July, when the eagles are on their nest sites, is especially critical. Hunting and snowmobiling may also have adverse effects, although the full extent of these disturbances have not yet been determined (Mathisen, 1973).

The size of the nesting territory also varies. Hensel et al (1964) defined territory as an area defended against competing members of the same species from the time of mating until the young are independent. They found that most territories had relatively uniform physical characteristics and that the extremities of the territories were marked by perching trees or loafing areas. The presence of good perch trees in the vicinity of the nest appears to be an important factor in nest site selection (Sprunt, 1973).

The linear distance between nesting sites and perching trees delineated the radius of each territory. The size of fourteen territories located around Karluk Lake, Kodiak National Wildlife Refuge, ranged from 28 to 112 acres and averaged 57 acres. Chrest (1964) reported identical territory sizes. Perches were located a maximum one fourth mile from the nest, and most territories were distinctly separated by open areas. Robards et al (1966) noted that eagles on Admiralty Island did not nest closer to each other than 700 yards.

Herrick (1924a) observed three different forms of basic nest structure. In cases where the upright branches of the nest tree were nearly vertical, the nest acquired a cylindrical form. Where the spread was greater, the nest had a cup form. As the nest built up, it acquired the shape of a wine glass or a tall inverted cone.

Herrick (1924a) noted that the size of materials used for nest construction varied from three feet long and two inches thick to the size of dried grasses. In Alaska, nests on Kodiak Island were frequently quite wet because of heavy rainfall. The materials used for nest construction and the age of the nest influenced how wet the nest would be. Newly constructed nests were less compact and drained better. Nests

containing hollow-stemmed cowparsnip (Heracleum sp.) also drained better. Older nests decomposed more rapidly and were unstable, often being destroyed by high winds occurring in that area (Chrest, 1964).

The bases of the nest platforms Chrest observed on Karluk Lake were normally constructed of dead cottonwood branches about three fourths of an inch in diameter and two feet long. Elder (Sambucus sp.) and alder branches were also used. Grasses were also woven in with the branches. Nest cavities here were lined primarily with bluejoint grass (Calamagrostis canadensis).

Robards et al (1966) observed eagles using drift picked up from the beaches on Admiralty Island for their nests. These eagles used sticks up to four feet long and two inches in diameter and lined their nests with grass, twigs, seaweed and other debris. It was also noted that nests which were not recently used supported a heavy growth of moss and grass. Robards (1973b) estimated that the weight of the sticks which the eagles carried never exceeded three pounds.

The size of the nest may be five to seven feet deep and six to eight feet in diameter, with nests both larger and smaller than this (USDA et al, 1972). Herrick (1924) observed a nest that was twelve feet deep and eight and one half feet in diameter and another nest that was eight feet deep and twelve feet in diameter. Chrest (1964) observed a range from four feet four inches to six feet five inches for nest diameter and a depth of less than two feet to almost four feet on Kodiak Island. Hensel et al (1964) reported the same data. Chrest (1964) also reported that the size of the nest depression which contained the eggs averaged fourteen inches in diameter and four inches deep.

Edwards (1969) conducted an extensive study of four bald eagle winter roost areas in Utah, Tooele and Juab Counties, Utah: the Tintic Roost in the East Tintic Mountains; the Fairfield Roost in Fairfield, Cedar Valley; the Oquirrh Roost in the Oquirrh Mountains; the Vernon Roost in Vernon, Rush Valley. The most extensively used areas were the Tintic and the Oquirrh, both of them canyons.

The Tintic and the Oquirrh roosts have certain common characteristics. They are located in side canyons leading to the west in the north-south trending ranges. They have a north exposure and Douglas fir are the primary perching trees. There are bowl-shaped ravines for protection. The elevation is about 6000 feet, which is 1200 feet above the

valley floor. The perching trees are located near the top of a ridge with easy access to the valleys. There is also freedom from human interference.

The valley roosts are used when the winter population is already high. Local storms decrease the number of eagles using these roosts, especially if there are high winds. Storms cause a decrease in all types of activity. Most birds stay perched at the canyon roosts.

Edwards also noted a great deal of soaring on clear days just after storms. A thorough mixing of the population was evident with noticeable changes in the numbers at each roost. He has also observed that the number of bald eagles using these roosts is increasing each year.

The eagles apparently have an attraction to particular trees and even to favorite limbs. These trees are usually large and open and have sufficient room for take off and landing, but they are not noticeably different from the other trees in the same general area. The first eagles to arrive at these roosts select the favorite trees and limbs. Eagles arriving later will land as close as possible, even on the same limb. A favorite tree may hold as many as twenty to twenty-five eagles before nearby trees are used.

The urge to return to the communal roosts is sufficient to cause late feeding eagles to fly several miles even though the flight is slow and labored. Eagles were observed to land on a limb already occupied and then side-step until all of the birds there were nearly touching. When many eagles are present at a roost, their calls can be heard for a considerable distance.

All of the eagles seem more tolerant of human interference at roosts to which they are used to returning. The different roost locations also seem to change behavior and human tolerance to some degree. Valley eagles could be approached more closely before they would take flight. Both valley roosts are near farm corrals and homes. The owner of the land at the Fairfield roost performed certain chores daily, some under the trees the eagles were perched in. However, the eagles were able to distinguish between human beings. The owner of the ranch was tolerated at close proximity, but Edwards, dressed similarly, was not permitted to approach as closely as the rancher.

7. Limiting Factors

The bald eagle is experiencing population losses from both direct and indirect causes. The major factor in direct loss is shooting. At least eleven bald eagles have died from thallium sulfate poisoning in Wyoming. The use of non-specific poisons is definitely dangerous to eagles. Electrocution has been another cause of bald eagle mortality, but the modification of existing lines and appropriate design of new installations minimizing the likelihood of fatal contacts should reduce that particular problem (Sprunt, 1972).

With the possible exception of shooting, these factors are not exerting limiting effects on bald eagle populations. The impact of shooting is greater on the southern bald eagle because of its low numbers, although in actuality more northern bald eagles are shot (Sprunt, 1973).

Over one hundred thousand eagles were killed during the years that the bounty was in effect in Alaska (Barnes, 1951; Robards et al, 1966). The effects of this killing of the bald eagle cannot be calculated since the original population had never been determined. At present, shooting mortality does not appear to be a limiting factor for Alaskan eagles.

The bald eagle populations in Alaska seem to be reproductively healthy. The comparative isolation of the state also serves as some protection from direct human-inflicted losses. Since the bounty has been eliminated, the number of eagles being shot is greatly reduced (Kenyon, 1961; Sprunt, 1972; Sprunt et al, 1973).

The development of Alaska may alter the comparative security that bald eagles presently have from human disturbances. Poulin (1968) and Corr (1969) conducted studies to attempt to determine the effects of logging on eagles. They found that all located nests were within three hundred and fifty yards of the seashore and most nest trees were much closer, placing the nesting habitat of eagles well within reach of the present logging practices in southeast Alaska.

The effects of logging on bald eagles nesting here is difficult to determine. The loss of potential nest sites and actual loss of some nests is obvious, but further effects are not clear. However, there appear to be fewer nesting pairs in this heavily logged area than on Admiralty Island, where logging is not presently being conducted. A potential problem is indicated by the fact that by 1972 over fifteen hundred nest

trees had been recorded in southeast Alaska and not one of them was located in a young stand of timber (USDA et al, 1972). Over seventeen hundred nest trees have now been located and marked for identification and protection.

The continental bald eagle populations are experiencing a number of difficulties. The chances of eagles being shot or poisoned are much greater because of the considerably larger numbers of people in the continental United States. In some situations, northern bald eagles may be locally limited, such as on San Juan Island, Washington. Here shooting may be functioning as a limiting factor. At least 75% of the population gain from annual production is lost through shooting mortality (Retfalvi, 1965).

The effects of human disturbance on nesting bald eagles are still being argued. In 1968, Mathisen published a paper indicating that human activity was not seriously affecting the eagles. Nests in very isolated parts of Chippewa National Forest were occupied 78% of the time and successful 54% of the time. Nests in areas where human beings and associated activities were frequent were occupied 79% of the time and successful 48% of the time.

Mathisen did point out that the timing of the disturbance in relation to the eagle's breeding chronology had importance. In Chippewa National Forest there was increased activity in mid-May, when the adults would have very small eaglets. Mid-June through the summer is when human activity would approach maximum levels, and by this time the young are half grown. Vulnerability to disturbance is greatest during egg-laying, incubation and when the eaglets are newly hatched.

Grier (1969) studied the effects of eagle behavior and productivity in response to human beings climbing into nests. Ninety territories were available for study in northwest Ontario. Forty-five were randomly selected to be climbed; the rest were not climbed. Both adults were present on 42 of 58 recorded climbs; one adult was present during fifteen climbs and no adults were present for one climb. The adults usually circled around 200 to 500 feet above the investigator and called. In 23 cases, the adults left the area.

The behavior of the eaglets went through four stages.

1. Up to four to five weeks of age, they either ignored the investigator or responded by approaching with food-begging behavior or as if seeking to be brooded.

2. From five to six weeks old, they called and raised their bodies, then returned to the resting position.

3. When they were six to nine weeks old, they faced the intruder, erected their feathers and flapped their wings. Some would leap towards the investigator and strike at him clumsily with their feet.

4. From the age of nine to eleven weeks, the eaglets attempted to escape by moving to the opposite side of the nest or onto a limb, facing away and looking as if seeking a place to jump to. If further excited, they glided to the ground.

After Grier left the nest vicinity, the adults returned to the nest area. When these nests were later checked, all activities appeared normal. His data indicated that censusing young eaglets two to eleven weeks old, either by climbing into the nest or observing from a distance, had no significant effect on productivity of bald eagles in northwest Ontario.

Grier felt that the types of human activity near the nests might affect the degree of disturbance caused by climbing into the nest. Eagles used to other human activities might be less disturbed than eagles having little contact with people. However, with considerable activity near the nests, climbing may be a sufficient additional stress to cause the eagles to desert.

Severe weather may affect the productivity of eagles in a given year. Broley (1947) reported on the effects of a hurricane in October, 1944, in Florida, which caused considerable damage to many eagle nests. The hurricane occurred four to six weeks before the usual laying period, and most nests were rebuilt in time for normal nesting, but in twenty-four rebuilt nests, no eggs were laid. In twenty-one nests where eggs were laid, they did not hatch although the adults incubated them for two months. It was also noted that the poultry in this area would not lay eggs for two to three weeks after the hurricane. It has been hypothesized that the rebuilding of the nests took so much time that the usual sequence of psychological and physiological states was retarded.

In a reproductively healthy population the factors discussed so far would not exert a limiting effect except possibly in local situations. However, evidence is accumulating that the continental United States bald eagle populations are experiencing lowered productivity and are steadily declining. The factors discussed to date may then be exerting a greater influence than normal.

Broley began banding bald eagles in Florida in 1939. By 1946 he was banding 100 eagles a season, working primarily with 125 nests on the Florida west coast from Tampa to Fort Meyers. In 1947, 41% of the nests he observed failed to produce young. In 1950, he observed a 78% nesting failure. Eleven nests produced fifteen young. Eggs in twelve other nests failed to hatch and 46 pairs of adults showed no breeding behavior. In 1955, only eight young were observed by Broley in the same 125-mile stretch from Tampa to Fort Meyers. In 1957, nesting failure was 86%. Broley was convinced that around eighty percent of the Florida eagles were sterile (Broley, 1950; 1958).

In 1959, the National Audubon Society began an investigation of the status of the bald eagle in Florida. Their data, based on Broley's work and some other records, indicated a population loss of 50% to 90% in various parts of Florida.

Some of this population loss could be attributed to a rapidly expanding human population and land development. Many nest trees were cut down or the habitat altered unfavorably for the eagle. The establishment of Cape Kennedy also had its influence, but this was not sufficient to explain the lack of production by eagles unaffected by development. Audubon studies showed that Everglades National Park had the highest eagle populations (Cunningham, 1960).

In 1961, the National Audubon Society began its Continental Bald Eagle Project, which included a January count of eagles to attempt to learn how many there were in the continental United States and to acquire information on eagle movements and the ratio of juveniles and adults.

The number of eagles reported varied from approximately 3500 to 3800 and averaged around 3700 for 1961-1963. No appreciable change had taken place up to 1966. Percentages of juveniles varied between 21% and 28%. Indications from past migration records at Hawk Mountain, Pennsylvania, are that a steady decline is occurring. From 1931 to 1945, 36.5% of the bald eagles passing through the area were juveniles. From 1954 to 1960, 23.1% were juveniles (Sprunt, 1961, 1963; Sprunt et al, 1961, 1962, 1963, 1966).

The one factor in all of the recorded cases of rapid decline is a lowering of the reproductive success. The normal rate of reproduction is not known, but studies in the Everglades, British Columbia and Alaska, along with Broley's early work and other records, indicate that a success rate of 50% to 75% or possibly higher might be expected from the nesting pairs in a stable population. None of the areas where a serious decline has occurred have a nesting success as high as fifty percent.

Data for five nesting seasons in northern Wisconsin indicated a success rate varying from a low of 26.8% in 1962 to a high of 61.9% during 1966. Eagle productivity will be affected by natural influences such as the severity of the winter preceding a particular breeding season. However, the decline is constant in spite of irregular fluctuations of other variables. In 1963, 21.6% of the bald eagles migrating through Hawk Mountain, Pennsylvania, were juveniles.

The observed reduction in breeding success in seriously declining populations such as the eagles in Maine (18% nesting success), Chesapeake Bay (15%), Great Lakes shores (4%), Florida west coast (45%) and Florida east coast (35%) is not primarily due to the reduction in the numbers of young produced per successful nest. The reduction is largely due to the almost complete lack of production from certain pairs of eagles (Sprunt, 1969; Sprunt et al, 1966).

Increased human pressure on eagle habitat is responsible for some of this lack of production. Bald eagles have a great tenacity towards their nesting sites and may simply stop nesting if they are displaced. An increase in affluence and mobility since World War II, with greater use of boats, off-road vehicles and snowmobiles and the proliferation of second homes on waterfront property has altered eagle habitat severely.

The removal of old trees which are preferred for nesting force the eagles to use substandard nest sites. In some cases, no possible nest sites are left. The removal of nest trees also occurs in "de facto" wildnerness areas where clear cutting or the removal of all "mature trees" is carried out. Increased siltation in streams resulting from clear cutting reduces the number of fish and increases the difficulty of the eagles catching the remaining fish, thus removing or reducing the primary food source. Industrial pollution, siltation and acid waste from mining operations are also detrimental in a number of areas (Barnes, 1951; Sprunt, 1968, 1969, 1972; Sprunt et al, 1966).

These factors are still inadequate to account for the catastrophic population declines which have been observed. The primary agents involved in this lowered productivity are the persistent chlorinated hydrocarbon pesticides. Organochlorine pesticide residues, specifically DDT and its metabolites, are highest where productivity is lowest. The continental bald eagle populations are experiencing severe eggshell thinning. DDE is the major metabolite affecting eggshell thinning.

Sampling and analysis of eagle eggs have shown a straight line relationship between the rate of reproduction and the amount of DDE and dieldrin present. The higher the residues, the lower the rate of production. Residues of DDT and dieldrin have been found in almost all food utilized by eagles, and have been found in nearly all eagles sampled.

Sublethal doses of DDE can cause reduced reproduction in birds of prey. Small quantities of DDE in the liver induce enzymes which hydroxylate certain steroid hormones, primarily estrogen, which causes abnormal calcium metabolism in the eagles. They do not seem able to store or utilize calcium; thin-shelled eggs are the result. These eggs suffer from mechanical breakage or the embryos fail to hatch. Bald eagle egg shells are significantly thinner than before 1945. Cases of severe reproductive failure can be correlated with high insecticide residues in the eggs (Sprunt, 1968, 1972).

Sprunt et al (1973) have conducted a study on the comparative productivity of six bald eagle populations. Checks of data collected before 1947 indicate that the productivity of bald eagles in the Chesapeake Bay area was around 1.8 young per active nest. In Florida, the figure was 1.61 per successful nest. These figures are higher than the present Alaskan eagle productivity ratio of one young per active nest and the Alaskan eagles are considered a healthy population reproductively.

Conclusions of this study were based on 2,037 nesting attempts. This data was collected for seven to twelve years for the different populations. Low productivity was due principally to fewer pairs of eagles producing young at a lower annual rate. This rate varied from one eaglet per nest in Alaska to .14 young per nest in the Great Lakes region. Thirty-five percent of the nests in Alaska produce two young annually while only three percent of the Great Lakes nests produced two young.

Of the six populations studied, those in Michigan, Maine and the Great Lakes are declining. The populations in Alaska, Wisconsin and the Everglades in Florida are presently stable. The numbers of breeding pairs in Michigan, Maine and the Great Lakes are declining annually. Figures indicate that at least fifty percent of the breeding pairs of bald eagles must be productive annually and produce between .5 and .7 young per year to maintain a stable population.

Studies have been made of the pesticide loads that different bald eagles are carrying. Mulhern et al (1970) analyzed 69 eagle carcasses and brains. All contained DDE residues; 68 contained dieldrin, 64 contained DDD and 39 had DDT. Thirty-four contained heptachlor epoxide. All of them had PCBs.

One of the major findings of Mulhern and associates is that eight eagles had concentrations of dieldrin in the brain within the lethal range. Experiments have shown that four ppm dieldrin in the brain is the lower lethal level. These eight eagles had from 3.6 to 9.5 ppm dieldrin in their brains. An immature female contained 20.3 ppm DDT plus 14.4 ppm DDD in the brain and is believed to have died from DDT poisoning, since experiments have shown that 30 ppm DDT + DDD in the brain is lethal.

Reichel et al (1969) analyzed 45 bald eagles and 21 golden eagles in 1964 and 1965. They found that DDE residues averaged 8.9 ppm for 29 bald eagle carcasses, whereas it was .49 ppm for 21 golden eagles. The diet of bald eagles consists mainly of fish and birds in areas which have received high pesticide applications, whereas golden eagles tend to be located in areas receiving smaller quantities of pesticides and exist primarily on a mammalian diet.

Krantz et al conducted a study of organochlorine residues in bald eagle eggs. They compared the residues in bald eagle eggs from Maine, where nesting success is very poor, with residues in eggs from Wisconsin and from the Everglades where nesting success is higher.

Five of nine Wisconsin eggs collected had no visible signs of development and four contained embryos three to twelve days old. Four late unhatched eggs showed no development either. Eggs collected from Maine throughout the nesting season were addled or dry. Five eggs collected in Florida had embryos six to thirty-one days old and one had no development.

Eggs collected from five non-productive nests in Maine had much higher residues of DDE and dieldrin than eggs collected from either productive or nonproductive nests in Wisconsin and Florida. DDE concentrations in Maine eggs averaged 21.76 ppm and dieldrin averaged 1.41 ppm. DDE in Florida eggs averaged 7.27 ppm and dieldrin averaged .21 ppm. Wisconsin eggs had 4.7 ppm DDE and .37 ppm dieldrin.

Studies of golden eagles in Scotland have revealed an interesting relationship between eagle productivity and dieldrin. Researchers noted that the proportion of eagles successfully producing young doubled following the ban on the use of dieldrin in sheep dips. The average dieldrin residues in the eagles also dropped, from .87 ppm to .38 ppm. A correlation has been shown between reproductive failure and amounts of dieldrin exceeding one ppm in the eggs of these golden eagles. One half of the bald eagle eggs from Maine and a few eggs from Michigan, Minnesota, Wisconsin and Florida have contained more than one ppm dieldrin. If the effects of dieldrin on golden eagles are the same in bald eagles, then dieldrin could be a factor in the lowered reproductive success in these areas (Wiemeyer et al, 1972).

DDE residues in some eggs are of the same magnitude that has caused egg shell thinning in experimental studies of other species. Average declines in shell thickness greater than seventeen percent have been accompanied by severe declines in populations and/or reproductive success in several species of raptors. The Florida bald eagle eggs analyzed had a seventeen percent change from the pre-1946 norms. Eggs from Kodiak, Alaska, exhibited a fourteen percent change and eggs in the Great Lakes states showed a twelve percent change from those norms. Even the Alaskan populations may yet experience reproductive failure because of the pesticide loads they are acquiring (Wiemeyer et al, 1972).

A survey of Maine eagles conducted in 1971 revealed eleven eaglets in thirty nests. Twenty-two nests had no eaglets. Calculations showed that it would take one hundred pairs of Maine eagles to produce thirty-five young. In Florida, one hundred pairs of eagles would produce seventy young. Wisconsin birds would average ninety-eight and Alaskan eagles would average one hundred four young per one hundred pairs (Anon., 1971).

Several studies have been conducted to attempt to determine the effects of pesticides on bald eagles. Locke et al (1966) studied spermatogenesis in bald eagles fed a diet containing varying dosages of DDT. Obvious testicular damage occurred at dosage levels that were also toxic, but these effects were not uniform. Their data suggested that DDT does not interfere with spermatogenesis except at toxic levels, but they were unable to determine if the sperm were normal or if the quantity of the sperm produced was reduced, as has been shown for chickens.

Stickel et al (1966) and Chura et al (1967) reported on studies involving the feeding of DDT at different dosage levels to bald eagles in captivity. Bald eagles fed 4000 ppm DDT daily exhibited tremors 12 to 18 days after the dosages were started and died 15 to 23 days later. Eagles fed 800 ppm exhibited tremors at 34 to 45 days and died at 59 to 62 days after the beginning of the dosages. Eagles fed 160 ppm DDT exhibited tremors at 55 days and one died at 71 days. Eagles fed 10 ppm DDT daily showed no evidence of tremors and none died.

Stickel and associates studied the kinetics of DDT and learned that the amount of DDT and DDD in the tissues of bald eagles increased between 60 and 120 days on dosage and decreased after the DDT was discontinued. DDE residues did not decrease after 60 days on clean food and increased in the liver because some of the DDT was converting to DDE.

Stickel et al concluded that a continuous intake of as much as five ppm DDT daily is unlikely to produce lethal amounts in the tissues of bald eagles. The DDT content of tissues increases slowly for many months before a metabolic balance is reached and is slowly lost when DDT is no longer being taken into the system. The conclusion of the study was that although bald eagles are exposed to DDT and dieldrin nationwide, only an occasional eagle will accumulate a lethal level of residues.

Chura et al (1967) reported the behavior of bald eagles on DDT dosages. Eagles that died ate little or no food immediately before death. All eagles studied in 1962, with the exception of one control, lost from 23% to 49% of their body weight between their capture and death or sacrifice.

Tremors attributed to DDT poisoning were evident in all but one bird of the 1962 eagles that died. The tremors were generally stronger in eagles receiving higher dosages of DDT. The tremors consisted of wing jerking and general incoordination simultaneous with vigorous feather shaking. Tremors and death occurred first in the eagles on the highest dosage.

A new possible threat to the bald eagle is the presence of polychlorinated biphenyls in the environment. PCBs are widely used industrial compounds sold in the United States under the trade name Aroclor. They are known to be toxic and are present in the environment in quantities similar to DDE. PCBs have been found in highest concentrations in water near industrial sites, in rainwater and in the air.

The highest residues of PCBs have been found in birds that feed on other birds or mammals. The lowest residues are found in birds that feed on insects. In twelve Alaskan bald eagle eggs, median PCB residues measured 1.65 ppm. The median value for eleven eggs from Maine, Michigan, Minnesota and Florida was 9.7 ppm.

Two eagles obtained from widely separated areas contained essentially identical PCBs, varying slightly in apparent concentration of specific compounds. Information on the ability of animals to alter PCBs is scarce, but several isomers were noted in the eagles that were not originally in the Aroclor. Effects besides toxicity are not known, but nineteen PCBs were present in these two eagles.

The toxicity of PCBs is similar to that of DDE. The toxicity of dieldrin and DDT is enhanced beyond an additive effect by the addition of PCBs containing fewer numbers of chlorine atoms. Toxic effects of DDE and Aroclor 1254 are additive but not synergistic.

Experiments have shown that PCBs increase the breakdown of estradiol in domestic pigeons and kestrels, demonstrating the capability of PCBs to induce microsomal enzyme activity. Ten-day-old ducklings exposed for ten days to a dietary dosage of 25, 50 or 100 ppm Aroclor 1254 showed 35% to 44% mortality on exposure to duck hepatitis virus, whereas mortality among birds not receiving Aroclor was 14%. Pheasants fed 50 milligrams of Aroclor daily for seventeen weeks produced fewer eggs than the controls and a higher percentage of the chicks pipped the shell but did not hatch. Hatched chicks weighed less and survived more poorly than the controls. Egg shell thickness was not affected (Bagley et al, 1970; Dustman et al, 1971).

The effects of PCBs on bald eagles are not known. However, it is one more contaminant of the environment which may add to the physiological stress that the bald eagle is experiencing. An inability to produce sufficient numbers of replacement offspring increases the seriousness of other factors such as shooting, poisoning and electrocution. The decreased use of chlorinated hydrocarbons should be followed by an increased reproductive success as the amounts of pesticides in the environment decrease.

8. Protective Measures Instituted

a. Legal or Regulatory

1. Title 54, Stat. 250, was passed by Congress and signed into law by the President to protect the bald eagle. This Bald Eagle Act was signed on June 8, 1940, but excluded the bald eagle in Alaska. Essentially this legislation orders that it is unlawful to take, possess, sell, purchase, barter, offer to sell, transport, export or import, at any time or in any manner, any bald eagle, also known as the American eagle, alive or dead, or any part, nest or egg of a bald eagle. This act also allows permits to be issued to collect bald eagles for scientific purposes and for the protection of wildlife or agricultural or other interests locally (Kalmbach et al, 1964).

2. On March 2, 1953, the territorial bald eagle bounty law was repealed in Alaska. This eagle may now be killed only when it is causing damage (Kalmbach et al, 1964).

3. Since 1966, by order of former Secretary of the Department of the Interior, Stewart Udall, eagle nesting sites located in all national wildlife refuges are closed to the public to help protect the birds from disturbance during the nesting season. An order was also issued which prevented timber cutting within one half mile of trees containing bald eagle nests and allowed for the preservation of potential nesting sites.

4. On February 8, 1972, the President of the United States issued an Executive Order banning the use of poisons on public lands.

b. Captive Rearing

1. The Patuxent Wildlife Research Center has developed facilities for the propagation of the northern and southern races of the bald eagle. The Center is attempting to develop methods of captive propagation to produce eagles to bolster wild populations or restore breeding pairs to depleted habitat (USDI, 1968).

Thacker (1971) published estimations of birds of prey in captivity in the United States as of 1971. His figures for bald eagles indicated that at least 30 were being used in research projects and at least 102 were in zoos.

c. Habitat Protection and Improvement

1. The Forest Service, in cooperation with the Bureau of Sport Fisheries and Wildlife, allows for the protection of bald eagle habitat in their management plans for the national forests and was the first federal agency to provide for bald eagle management on public lands. All management plans include measures to protect the nest sites and their buffer zones to minimize disturbance of the eagles during nesting season. Functional resource plans must evaluate the effect on nesting sites, including those outside but within one-half mile of forest boundaries. This is especially important for activities such as insecticide spraying, aquatic plant control and the use of fish toxicants.

All nests must be located and these locations shown on appropriate maps along with the buffer zones for each nest to permit the modification of timber cutting adjacent to the nests. Development activities within a half mile of any nest tree must be limited to measures beneficial to the nesting site. Timber cutting, timber stand improvement, prescribed burning, road construction, recreation construction, and other disturbing activities are not allowed within the buffer zone during nesting season. Timber sale contracts contain provisions restricting timber cutting in accordance with these management directives. Three to five old-growth trees must be reserved for roosting and potential nest trees within the buffer zone surrounding the nest.

Special management consideration must be given to all areas known to contain or suspected to contain active nests. The Forest Service also cooperates with the National Audubon Society on maintaining current maps and inventories of bald eagles as well as recordkeeping, publicity, studies, and an annual midwinter census of eagle nesting areas (Forest Service, 1969).

2. Several islands in Seymour Canal on Admiralty Island, Tongass National Forest, Alaska, have been designated as the Seymour Eagle Management Area. The shorelines of these islands are typical of bald eagle habitat in southeast Alaska in population density, location, type of nests, and variety of food available. Trails, observation points, photography blinds and public use shelters will be added to the area over a period of time to permit increased observation of the bald eagle and other wildlife. Although the area is primarily for the bald eagle, recreation such as fishing and camping will continue. No commercial development will be allowed (USDA et al, 1972).

3. The Florida Audubon Society has obtained agreements with landowners for 2,300,000 acres of private land where nests are located to be treated as bald eagle sanctuaries. The Society inspects these nesting sites annually (Sprunt et al, 1962, 1966; USDI, 1968).

4. In 1972, the Alaska State Legislature enacted HB 614, which lists several areas in the State as critical habitat. The stretch of the Chilkat River which in some years may support 3000 to 3500 bald eagles is one of the areas listed. The purpose of the legislation is to protect and preserve habitat areas especially crucial to the perpetuation of fish and wildlife and to restrict all other uses not compatible with that primary purpose. Before the use, lease or other disposal of land under private ownership or state jurisdiction and control, plans must be submitted for the anticipated use, specifications given for proposed construction work, proper protection of fish and game and approximate date when the construction or work is to begin. Written approval from the Commissioner of Fish and Game is required before construction is begun (Robards, 1973b).

d. Reintroduction

1. There are no known attempts to reintroduce the bald eagle into formerly occupied territory.

9. Recommended Species and Habitat Management Techniques

1. Since some populations of H. l. alascanus are in greater danger of extirpation than some populations of H. l. leucocephalus, manage the individual populations as is done with other species of wildlife such as waterfowl and big game (Sprunt, 1972).

2. At certain times of the year, bald eagles gather at communal roosts, usually near a source of food and/or shelter. The sites of such roosts should be protected against encroachment by man's activities or destruction from timbering or other development (Sprunt, 1972).

3. Increase raptor protection and enforcement of federal laws with the cooperation of state game and fish agencies because they have more manpower to accomplish this than the federal agents (Sprunt, 1972).

4. The closing off of an area from human activity during incubation and when the eaglets are very small may reduce nest desertion by adults. Once the young are half grown and the likelihood of desertion is greatly reduced, these areas can be opened up for utilization again by people.

5. Encourage private land holders to protect bald eagle nesting sites (Sprunt et al, 1966).

6. Establish public education programs designed to enable the public, especially those who use firearms, to identify bald eagles in all plumage phases, to be able to separate juvenile bald eagles from golden eagles and hawks and encourage them not to shoot raptors of any species (Sprunt et al, 1962). In spite of the treaty signed in March, 1972, with Mexico, which now protects all birds of prey, shooting of raptors continues.

7. All of the 1700 nest trees located in Alaska as of 1972 are in old-growth stands. In Minnesota nearly all eagle nests that have been studied are located in trees over 100 years old. The maintenance of suitable old trees for potential nesting sites by bald eagles where timber is being cut or where land development involves the removal of trees may be helpful in reducing habitat deterioration.

8. Prohibit the use of poisons in areas where bald eagles are nesting or roosting during the winter.

9. Whenever a land transfer is made from federal to private or state ownership, attempt to insure that provisions are made for the protection of any bald eagles and eagle habitat that may be included in the land being transferred.

10. Ongoing Research Projects

1. Dr. L. D. Frenzel, Jr., a professor in the Department of Entomology, Fisheries, and Wildlife at the University of Minnesota, St. Paul, Minnesota, is directing several graduate students in continuing studies of the bald eagle on the Chippewa National Forest. Joel Kussman is completing an extensive study of bald eagle behavior, including data on the post-fledging activities of juvenile bald eagles. The information obtained from this study will be released and some of it published as soon as his Ph.D. dissertation is completed. The tentative thesis title is "Nesting and Post-Fledging Behavior of the Bald Eagle in the Chippewa National Forest, Minnesota." Greg Juenemann has studied the details of eagle nesting habitat and the effects of recreation, logging and other disturbances on nesting success (Kussman, 1973b; Rossman et al, 1971).

2. John Mathisen, a wildlife manager employed by the Forest Service to work in Chippewa National Forest, has been banding eaglets and locating eagle nests for several years (Rossman et al, 1971).

3. The Bureau of Sport Fisheries and Wildlife and the Forest Service in Alaska have been cooperating by describing and charting on maps any eagle nests located in the national forests. A new nest card is completed each time any changes are observed in nest status. All eagles seen along selected beach areas are recorded to study seasonal fluctuations. Food habits are also being noted as time and opportunity permit. Fred C. Robards is beginning a color marking and bird movement study in 1973. Certain mated pairs and their eaglets will also be banded to learn more about the eagle family unit and whether or not they return to the same nesting site. Other plans include an in-depth study of food-parental care and fledgling mortality (Robards, 1973a).

4. The National Audubon Society is continuing studies on population fluctuations and nesting productivity of several populations of both northern and southern bald eagles in the continental United States.

5. The Bureau of Sport Fisheries and Wildlife, Patuxent Wildlife Research Center, is monitoring and studying pesticidal contaminants in the environment and in bald eagles.

6. The Bureau of Sport Fisheries and Wildlife, the Forest Service, the Bureau of Land Management, the National Audubon Society and other groups and individuals are all exploring ways to increase public awareness and knowledge of the bald eagle and the problems affecting it in the hopes that at least some factors such as shooting and nest disturbance will be reduced by increased public concern and actions favorable to the bald eagle.

11. Authorities

1. Fred C. Robards (H. l. alascanus)
Game Management Agent
Bureau of Sport Fisheries and Wildlife
U. S. Department of the Interior
P. O. Box 1287
Juneau, Alaska 99801

2. Alexander Sprunt, IV (H. l. leucocephalus and H. l. alascanus)
National Audubon Society
115 Indian Mound Trail
Tavernier, Florida 33070

3. James W. Grier (H. l. leucocephalus and H. l. alascanus)
Cornell University
Division of Biological Sciences and Laboratory of Ornithology
Ithaca, New York 14850

4. John Mathisen (H. l. alascanus)
U. S. Forest Service
Chippewa National Forest
Cass Lake, Minnesota 56633

12. Governmental, Private and International Organizations Actively Involved With This Species' Welfare

A. 1. National Audubon Society
950 Third Avenue
New York, New York 10022

2. The major objective of the National Audubon Society is to advance public understanding of the value and need for conservation of our wildlife, its habitat, and all natural resources, and the relationship of such wise use and intelligent treatment to human progress.

3. Alexander Sprunt, IV, Research Director

4. National Audubon has a series of leaflets and charts on birds of prey and has concentrated its efforts for raptors in the area of education and protective legislation. The National Audubon Society sponsored the Continental Bald Eagle Project, beginning in the early 1960's. The Society also provided funds for Edwards' study on bald and golden eagles in Utah, Retfalvi's study on San Juan Island, Washington, Grier's studies in northwest Ontario, Hancock's studies in British Columbia, plus other projects in the United States and Canada. Audubon biologists have been very active in collecting productivity data on continental bald eagle populations.

B. 1. Bureau of Sport Fisheries and Wildlife
Office of Endangered Species/International Activities
Washington, D. C. 20240

Patuxent Wildlife Research Center
Laurel, Maryland 20810

2. The Office of Endangered Species is responsible for scientific study and propagation of threatened wildlife species. The objectives are to obtain needed information on the distributional, behavioral, ecological, physiological, genetic and pathological characteristics of threatened species in the wild so as to identify and evaluate limiting factors and find means of correcting them and to maintain captive populations of these wildlife species for study and for the production of suitable stock needed to restore or bolster populations in the wild.

3. Keith Schreiner, Chief, Office of Endangered Species

4. The Bureau of Sport Fisheries and Wildlife is responsible for the management and protection of the bald eagle.

C. 1. Bureau of Sport Fisheries and Wildlife - Alaska Area
P. O. Box 1287
Juneau, Alaska 99801

2. The BSFW aids in the conservation of migratory birds, certain mammals and sport and commercial fishes. This includes the application of research findings in the development and management of a system of national wildlife refuges for migratory birds and endangered species and the acquisition and application of technical knowledge necessary for perpetuation and enhancement of fish and wildlife sources.

3. Fred C. Robards, Game Management Agent

4. The Alaska Area BSFW cooperates in the management of the Seymour Eagle Management Area, Admiralty Island, Tongass National Forest, Alaska, and collects data on life history, ecology and management techniques for bald eagles in Alaska.

D. 1. Forest Service, Region 10, Alaska
Federal Office Building, Box 1628
Juneau, Alaska 99801

2. The Forest Service administers the national forests and national grasslands and is responsible for the management of their resources. Cooperates with federal and state officials in the enforcement of game laws on the national forests and in the development and maintenance of wildlife resources.

3. Sigurd T. Olson, Division of Recreation, Lands, Wildlife, and Watershed Management

4. Region 10 cooperates in the management of the Seymour Eagle Management Area, Admiralty Island, Tongass National Forest, Alaska, and cooperates with the Bureau of Sport Fisheries and Wildlife in the protection of nesting habitat for bald eagles in the national forests located in Alaska.

E. 1. Alaska Department of Fish and Game
Subport Building
Juneau, Alaska 99801

2. The Alaska Department of Fish and Game is responsible for the management of wildlife in Alaska.

3. Not known

4. This agency cooperates in the management of the Seymour Eagle Management Area, Admiralty Island, Tongass National Forest, Alaska.

F. 1. Forest Service
Washington, D. C. 20250

2. The Forest Service administers the national forests and national grasslands and is responsible for the management of their resources. Cooperates with federal and state officials in the enforcement of game laws on the national forests and in the development and maintenance of wildlife resources.

3. Division of Wildlife Management

4. The Forest Service cooperates with the Bureau of Sport Fisheries and Wildlife in the protection of nesting habitat for bald eagles in the national forests and was the federal agency to establish a basic management plan for bald eagles on public lands.

13. Photographic Materials Available

The Bureau of Sport Fisheries and Wildlife, the Forest Service and the National Audubon Society all have photographic material on bald eagles. The National Audubon Society and the Cornell Laboratory of Ornithology in 1962 also released a thirty-three minute, sixteen-millimeter film called "The Bald Eagle, Our National Bird." A film entitled "Everybody's Eagle" is available from the National Wildlife Federation.

14. The Value of a Bald Eagle

The bald eagle was well chosen to be a symbol of the United States, for its distribution is restricted to the North American continent. In truth it has none of the anthropomorphic characteristics ascribed to it. It is an avian predator that evolved in response to an ecological niche that

became available for exploitation. It has successfully filled this niche for thousands of years and may continue to do so until that niche no longer exists.

The flag of the United States, as the symbol of this nation, is protected from defilement of any sort by fines and imprisonment. The bald eagle, also a symbol of this country, is protected in a like manner. Yet otherwise law-abiding citizens are still shooting eagles.

The problems that both land and wildlife managers must confront in relation to the bald eagle are not merely scientific ones. Substantial data has been collected on the food habits of the bald eagle, indicating that it preys primarily on species that have no commercial value. Demands for eagle control are still made. Emotional factors will also have to be taken into consideration in order to formulate effective management plans. The most intangible factor to deal with may be the determination of the value of a bald eagle, for this obviously will not be the same thing for everyone.

Many groups and individuals have applied themselves to the problems of stopping unnecessary habitat destruction and the shooting of eagles. A number of different approaches have been taken, but none has been successful. An effective common denominator seems to be the impact that the living birds themselves have when attempts to educate the public are made. The opportunity to see an eagle at close range and to watch it respond to its immediate environment while learning about it has done much to dispel the bad reputation and publicity that eagles have been subjected to.

Only a very small fragment of the more than two hundred million people living in this country shoot eagles. But a large percentage of these people use pesticides. While "emotionalism" is decried by most individuals and organizations, scientific fact does not seem adequate to control the factors adversely affecting bald eagle populations. Perhaps people will have to become emotional about the bald eagle, an emotionalism based on fact, before efforts to help the bald eagle will be truly effective.

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APPENDIX

I. Governmental, Private and International Organizations Actively Involved with This Species' Welfare

A. 1. National Wildlife Federation
1412 16th Street N.W.
Washington, D.C. 20036

2. The objectives of the National Wildlife Federation are to create and encourage an awareness among the people of the United States of the need for wise use and proper management of the earth's resources.

3. James Davis

4. The National Wildlife Federation has released a film on bald eagles, is sponsoring a bounty on eagle shooters, and is also involved in other activities.

B. A number of individuals and groups such as the National Wildlife Federation, the Nature Conservancy, and others are making efforts to obtain bald eagle preserves in the states the eagles inhabit. Information about such efforts and related activities should be available from local chapters.

II. An additional list of investigators conducting studies on the bald eagle in the United States and Canada:

A. Sergej Postupalsky (Michigan and Ontario)
Department of Wildlife Ecology
University of Wisconsin
Madison, Wisconsin 53706

B. Charles R. Sindelar (Wisconsin)
456 Baird Street
Waukesha, Wisconsin 53186

C. Jon Gerrard and Doug Whitfield (Saskatchewan and Manitoba)
954 15th Ave. S.E.
Minneapolis, Minnesota 55414

D. Dr. Joseph R. Murphy (Western U.S. and the Aleutian Islands of Alaska)
Dept. of Zoology
Brigham Young University
Provo, Utah 84601

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